



## PATENT COOPERATION TREATY

PCT

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INTERNATIONAL PRELIMINARY EXAMINATION REPORT  
(PCT Article 36 and Rule 70)

Applicant's or agent's file reference PJP40617PCT1		<b>FOR FURTHER ACTION</b> See Notification of Transmittal of International Preliminary Examination Report (Form PCT/PEA/416)	
International application No. PCT/EP 0350616	International filing date (day/month/year) 09.09.2003	Priority date (day/month/year) 09.09.2002	
International Patent Classification (IPC) or both national classification and IPC G06F17/50			
Applicant THE MAIA INSTITUTE et al.			
<p>1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.</p> <p>2. This REPORT consists of a total of 8 sheets, including this cover sheet.</p> <p><input checked="" type="checkbox"/> This report is also accompanied by ANNEXES, i.e. sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).</p> <p>These annexes consist of a total of 9 sheets.</p>			
<p>3. This report contains indications relating to the following items:</p> <p>I <input checked="" type="checkbox"/> Basis of the opinion</p> <p>II <input type="checkbox"/> Priority</p> <p>III <input type="checkbox"/> Non-establishment of opinion with regard to novelty, inventive step and industrial applicability</p> <p>IV <input type="checkbox"/> Lack of unity of invention</p> <p>V <input checked="" type="checkbox"/> Reasoned statement under Rule 66.2(a)(ii) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement</p> <p>VI <input type="checkbox"/> Certain documents cited</p> <p>VII <input type="checkbox"/> Certain defects in the international application</p> <p>VIII <input type="checkbox"/> Certain observations on the international application</p>			
Date of submission of the demand  24.03.2004		Date of completion of this report  30.11.2004	
Name and mailing address of the international preliminary examining authority:  European Patent Office D-80298 Munich Tel. +49 89 2399 - 0 Tx: 523656 apmu d Fax: +49 89 2399 - 4465		Authorized Officer  Lerbinger, K  Telephone No. +49 89 2399-2274 	

# INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No. PCT/EP 03/50616

## I. Basis of the report

1. With regard to the **elements** of the international application (*Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report since they do not contain amendments (Rules 70.16 and 70.17)*):

### Description, Pages

1-76 as originally filed

### Claims, Numbers

1-48 received on 05.10.2004 with letter of 05.10.2004

### Drawings, Sheets

1/31-31/31 as originally filed

2. With regard to the **language**, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.

These elements were available or furnished to this Authority in the following language: , which is:

- ☐ the language of a translation furnished for the purposes of the international search (under Rule 23.1(b)).
- ☐ the language of publication of the international application (under Rule 48.3(b)).
- ☐ the language of a translation furnished for the purposes of international preliminary examination (under Rule 55.2 and/or 55.3).

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

- ☐ contained in the international application in written form.
- ☐ filed together with the international application in computer readable form.
- ☐ furnished subsequently to this Authority in written form.
- ☐ furnished subsequently to this Authority in computer readable form.
- ☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.
- ☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. The amendments have resulted in the cancellation of:

- ☐ the description, pages:
- ☐ the claims, Nos.:
- ☐ the drawings, sheets:

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5. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed (Rule 70.2(c)).

*(Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report.)*

6. Additional observations, if necessary:

**V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement**

1. Statement

Novelty (N)	Yes: Claims	1-48
	No: Claims	
Inventive step (IS)	Yes: Claims	
	No: Claims	1-48
Industrial applicability (IA)	Yes: Claims	1-48
	No: Claims	

2. Citations and explanations

**see separate sheet**

**Item V**

**Reasoned statement with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement**

**1 Reference is made to the following documents:**

- D1: Motoharu Hosoi et al., "Dynamical Model of a Pedestrian in a Crowd", IEEE International Workshop on Robot and Human Communication, 1996  
D2: Dirk Helbing and Péter Molnár, "Social force model for pedestrian dynamics", Physical Review E, Vol. 51, Nr. 5, May 1995, 4282-4286

**2 *Clarity and Conciseness***

Independent method claims 1, 38, and 44 to 48 do not meet the requirements of Article 6 PCT as to conciseness and clarity. Moreover, the wording of numerous claims is also not clear within the meaning of Article 6 PCT.

2.1 Claims 1 and 38 have been drafted as separate independent claims. They both are directed to a method of simulating movement of an autonomous entity through an environment and differ merely in that claim 1 defines that 'determining said preferred step comprises determining a first dissatisfaction function for expressing a cost of taking a step comprising a sum of an inconvenience function for expressing a cost of deviating from a given direction and a frustration function for expressing a cost of deviating from a given speed' whereas claim 38 further defines that 'if said preferred step is not feasible determining a comprise step, wherein determining a comprise step includes: defining a neighbourhood; scanning said neighbourhood for obstacles; determining at least one condition relating to said obstacles and defining an area in which to seek a step towards said destination in dependence upon said at least one condition'. Therefore they differ from each other only with regard to the definition of a further feature. The aforementioned claims therefore lack conciseness and as such do not meet the requirements of Article 6 PCT.

2.2 Claim 44 is directed to an apparatus configured to perform the method according to any one of claims 1 to 43. Each of claims 45 to 48 is directed to an apparatus for simulating movement of an autonomous entity through an environment; each of these claims defines several means for performing several of the steps defined in the method claims 1 to 43. The aforementioned claims therefore lack

conciseness and as such do not meet the requirements of Article 6 PCT.

- 2.3 The phrase 'determining a first dissatisfaction for expressing a cost of taking a step comprising a sum of an inconvenience function for expressing a cost of deviating from a given direction and a frustration function for expressing a cost of deviating from a given speed' in claim 1 is obscure because this phrase merely mentions abstract concepts, such as cost of a step, cost of deviating from a given direction and cost of deviating from a given speed. It is completely unclear which technical features are intended to be described by this phrase.
- 2.4 The phrase 'determining a region in which to seek a comprise step and determining whether at least one comprise step is feasible' in claim 2 attempts to define the subject-matter in terms of the result to be achieved, which merely amounts to a statement of the underlying problem, without providing the technical features necessary for achieving this result.
- 2.5 The phrase 'determining said region in dependence upon at least one locally perceivable condition' in claim 4 is obscure because the expression 'perceivable condition' does not have a well-recognized meaning.
- 2.6 The phrase 'determining the inconvenience function for expressing a cost of deviating from a given direction' in claim 9 is obscure because it attempts to define the subject-matter in terms of the result to be achieved, which merely amounts to a statement of the underlying problem, without providing the technical features necessary for achieving this result.
- 2.7 The phrase 'revising said model of said building structure in dependence upon movement of said at least one entity' in claim 34 is obscure because it attempts to define the subject-matter in terms of the result to be achieved, which merely amounts to a statement of the underlying problem, without providing the technical features necessary for achieving this result.

**3** *Inventive step*

The present application does not meet the criteria of Article 33(1) PCT, because the subject-matter of all claims, i.e. claims 1 to 48, does not involve an inventive step in the sense of Article 33(3) PCT.

3.1 Present claim 1 defines a mixture of technical and non-technical features. The general requirement that an invention must have technical character leads to the conclusion that the patentability of an invention within the meaning of Article 33(1) PCT is derivable only from features which contribute to that technical character. Therefore, features which make no such contribution should be ignored when examining the claimed invention for novelty and inventive step. Consequently, if as a whole the subject-matter claimed has technical character, the assessment of inventive step should confine itself to the features which contribute to that technical character.

The document D1 is regarded as being the closest prior art to the subject-matter of claim 1, and discloses (the references in parentheses applying to this document) in the section '2 Modeling' a method of simulating movement of an autonomous entity through an environment (title: Dynamical Model of a Pedestrian in a Crowd), the method comprising:

providing a provisional path through a model of the environment from a current location to an intended destination (figure 1; section 2 Modeling: (1) A person plans a path to his destination and walks along the path);

providing a profile of said autonomous entity (section 2.1 Dynamical Model of the Walking Behavior; and section 2.3 Tracking Behavior:  $\theta_i$  and  $l_i$  are parameters, which describe the personality, and are different from person to person);

determining a preferred step towards said intended destination based upon said profile and said provisional path (section 2.4 Avoidance Behavior: If an obstacle, which is given the highest evaluation, disturbs movement of a person  $i$ , he intends to avoid it so that he may not collide with it).

The subject-matter of claim 1 differs from this known simulation method in that

- (a) determining said preferred step comprises determining a first dissatisfaction function for expressing a cost of taking a step comprising a sum of an inconvenience function for expressing a cost of deviating from a given direction and a frustration for expressing a cost of deviating from a given speed,
- (b) a personal space is determined around the autonomous entity, and
- (c) it is determined whether the preferred step is feasible by considering whether obstructions infringe the personal space.

The first difference, i.e. item (a), relates to a purely abstract considerations in

design of the algorithm. Technical aspects first come into play with the implementation of these considerations. However, the implementation of these considerations in the method of document D1 requires only minor modifications and comes within the normal working practice of the skilled person.

Features (b) and (c) have to be contrasted with the teaching of document D1, in which a rectangular area is identified as an avoidance area. This area includes the obstacle surrounded by a circle (section 2 Modeling, item (3)). If the simulation path falls within the avoidance area of the obstacle, the planned path is changed so that the new path no longer falls within the circle (section 2 Modeling, item (4) and figures 1 and 4).

The two features (b) and (c) identified above are therefore an obvious alternative formulation of the basic idea how to avoid a collision in the simulation of an autonomous entity.

Therefore the solution proposed in claim 1 of the present application cannot be considered as involving an inventive step.

- 3.2 Independent claim 34 is directed to a method of designing a building structure. The claimed method comprises three steps and differs from the method as defined in claim 1 in
- (a) providing a model of said building; and
  - (b) revising said model of said building structure in dependence upon movement of said at least one entity.

Citations 4 to 6 of document D1 have the title "A Study of Pedestrian Movement in Architectural Space". Therefore it is straightforward for the skilled person to use the obvious simulation method according to claim 1 in a method of designing a building structure as defined independent claim 34. In particular since this claim does not define any technical feature specifically addressing problems related to designing a building structure or problems arising in simulating movement of an autonomous entity in a building structure. Therefore the subject-matter of independent claim 34 is also not considered inventive.

- 3.3 The dependent claim do not contain any features which, in combination with the features of any claim to which they refer, meet the requirements of the PCT in respect of inventive step because the subject-matter of these claims, as far as it

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can be understood, is already known from document **D1** or constitutes an obvious modification or implementation of ideas discussed in **D1** and/or **D2**.

- 3.4 The same reasoning applies, mutatis mutandis, to the subject-matter of the corresponding independent claims 44 to 48, which therefore are also considered not inventive.



## Claims

1. A method of simulating movement of an autonomous entity through an environment, the method comprising:
  - 5 providing a provisional path through a model of the environment from a current location to an intended destination;
  - providing a profile for said autonomous entity;
  - determining a preferred step towards said intended destination based upon said profile and said provisional path;
  - 10 determining a personal space around said autonomous entity;
  - determining whether said preferred step is feasible by considering whether obstructions infringe said personal space.
2. A method according to claim 1, wherein if the preferred step is not feasible,
  - 15 then the method further comprises:  - determining a region in which to seek a compromise step and
  - determining whether at least one compromise step is feasible.
3. A method according to claim 1 or 2, comprising choosing one of a plurality
  - 20 of compromise steps.
4. A method according to any preceding claim, wherein determining said region includes adapting within said region in dependence upon at least one locally perceivable condition.
  - 25
5. A method according to any preceding claim, wherein determining said region includes adapting within said region in dependence upon memory of past conditions.
- 30 6. A method according to any preceding claim, wherein the determining of said personal space comprises defining a region in which absence of obstructions is sought.

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7. A method according to any preceding claim, wherein obstructions include other autonomous entities.

8. A method according to any preceding claim, wherein obstructions include  
5 fixed obstructions.

9. A method according to any preceding claim, wherein the determining of the preferred step comprises determining a first dissatisfaction function comprising a sum of an inconvenience function and a frustration function.

10. A method according to claim 9, comprising determining the inconvenience  
10 function.

11. A method according to claim 10, wherein the provisional path includes a  
15 direction from said current location to said intended destination and the profile includes a preferred step length, and wherein the determining of the inconvenience function includes:

determining a first amount of work required to take a step of given step  
length;

20 determining a second amount of work which is a proportion of said first amount of work corresponding to a component which is not directed in said optimal direction.

12. A method according to claim 10 or 11, wherein the determining of the  
25 inconvenience function includes:

determining an acceleration associated with a change in velocity between said step and a previous step and

determining a third amount of work required to produce said acceleration.

30 13. A method according to claim 12, wherein the determining of the inconvenience function includes summing said second and third amounts of work.

14. A method according to any one of claims 9 to 13, comprising determining the frustration function.

15. A method according to claim 14, wherein the profile includes a preferred walking speed and the determining of the frustration function comprises:  
determining a preferred instantaneous walking speed by adding said preferred walking speed to walking speed noise;  
determining a fourth amount of work dependent upon a difference between the walking speed and the preferred instantaneous walking speed.

16. A method according to any one of claims 9 to 15, wherein the determining of said preferred step comprises:

minimising said first dissatisfaction in respect of step length;  
minimising said first dissatisfaction in respect of step orientation;  
thereby to obtain a preferred step length and a preferred step orientation.

17. A method according to any preceding claim, wherein the determining whether said preferred step is feasible comprises determining whether there is any discomfort arising from the entity having to keep a distance which is less than a preferred distance from an obstruction.

18. A method according to claim 17, further comprising if there is discomfort arising from the entity having to keep a distance which is less than a preferred distance from an obstruction.

19. A method according to any preceding claim, comprising:  
providing a preferred clearance tolerance for said entity; and  
determining a personal space around said entity in dependence upon said clearance tolerance.

20. A method according to claim 19, comprising:  
determining a density of neighbouring entities and

determining said personal space around said entity in dependence upon said clearance tolerance and said density of neighbouring entities.

21. A method according to claim 19 or 20, comprising:  
5 providing information relating to velocity of said entity; and  
determining an angular dependency for said personal space in dependence upon said velocity.

22. A method according to any preceding claim, wherein said considering  
10 whether obstructions infringe said personal space comprises:  
determining whether said personal space is infringed at a first position along said preferred step and  
determining whether said personal space is infringed at a second position along said preferred step.

23. A method according to claim 22, wherein said considering whether  
15 obstructions infringe said personal space further comprises:  
determining whether said personal space is infringed at a third position along said preferred step.

24. A method according to any preceding claim, wherein if the preferred step is  
20 not feasible, then the method further comprises:  
determining a region in which to seek a compromise step.

25. A method according to claim 24, wherein the determining of said region  
25 comprises defining an arc.

26. A method according to any preceding claim, further comprising:  
determining a set of attributes for said autonomous entity in dependence  
30 upon said profile.

27. A method according to claim 26, wherein the determining of said set of attributes at least attributes comprises:

determining at least one attribute at time of generating said entity.

28. A method according to claim 26, further comprising:  
modifying at least one attribute of said set of attributes for said autonomous  
5 entity.

29. A method according to any preceding claim, wherein providing said profile  
for said autonomous entity comprises:  
basing said profile on a set of measured attributes.

30. A method according to any preceding claim, wherein providing said profile  
for said autonomous entity comprises:  
statistically assigning said profile.

31. A method according to any preceding claim, wherein providing said profile  
for said autonomous entity comprises:  
providing said profile in dependence upon at least one aspect of said  
environment.

32. A method according to any preceding claim, wherein providing said  
provisional path through said model of the environment from said current location  
to said intended destination comprises:  
determining a bearing from said current location to said intended  
destination.

33. A method of simulating movement of an autonomous entity through an  
environment, the method comprising:  
providing a preferred clearance tolerance for said entity; and  
30 determining a personal space around said entity in dependence upon said  
clearance tolerance.

34. A method according to claim 33, comprising:  
determining a density of neighbouring entities and  
determining said personal space around said entity in dependence upon said  
clearance tolerance said density of neighbouring entities.
- 5 35. A method according to claim 33 or 34, comprising:  
providing information relating to velocity of said entity; and  
determining an angular dependency for said personal space in dependence  
upon said velocity.
- 10 36. A method of designing a building structure, the method comprising:  
providing a model of said building structure;  
simulating movement of at least one entity through said building structure,  
according to any preceding claim; and  
15 revising said model of said building structure in dependence upon movement  
of said at least one entity.
37. A method of controlling movement of an entity through an environment, the  
method comprising:  
20 providing a provisional path through a model of the environment from a  
current location to an intended destination;  
providing a profile for said autonomous entity;  
determining a preferred step towards said intended destination based upon  
said profile and said provisional path;  
25 determining a personal space around said autonomous entity;  
determining whether said preferred step is feasible by considering whether  
obstructions infringe said personal space.
38. A method of determining a path of an autonomous entity through an  
30 environment, the method comprising:  
providing a provisional path through a model of the environment from a  
current location to an intended destination; and

determining a step towards said intended destination while minimising deviation from said provisional path.

39. A method according to any preceding claim, comprising:

5 determining said step towards said intended destination while minimising deviation from a preferred speed.

40. A method according to any preceding claim, comprising:

10 selecting said step towards said intended destination while maintaining at least a minimum distance from obstacles.

41. A method according to any preceding claim, comprising:

15 defining a neighbourhood;  
scanning said neighbourhood for obstacles;  
determining at least one condition relating to said obstacles and  
defining an area in which to seek a step towards said destination in  
dependence upon said at least one condition.

20 42. A method of simulating movement of an autonomous entity through an environment from a current location to an intended destination, the method comprising:

25 defining a neighbourhood;  
scanning said neighbourhood for obstacles;  
determining at least one condition relating to said obstacles and  
defining an area in which to seek a step towards said destination in  
dependence upon said at least one condition.

43. A method according to claim 41 or 42, wherein determining said at least one condition relating to said obstacles comprises:

30 determining a density of one type of obstacle.

44. A computer program for performing the method according to any preceding claim.

45. A computer-readable medium storing the computer program of claim 44.

46. Apparatus configured to perform the method according to any one of claims  
5 1 to 43.

47. Apparatus for simulating movement of an autonomous entity through an environment, the apparatus comprising:

- 10 means for providing a provisional path through a model of the environment from a current location to an intended destination;
- means for providing a profile for said autonomous entity;
- means for determining a preferred step towards said intended destination based upon said profile and said provisional path;
- means for determining a personal space around said autonomous entity;
- 15 means for determining whether said preferred step is feasible by considering whether obstructions infringe said personal space.

48. Apparatus for simulating movement of an autonomous entity through an environment, the apparatus comprising:

- 20 an interface for providing a provisional path through a model of the environment from a current location to an intended destination;
- an interface for providing a profile for said autonomous entity;
- a processor for determining a preferred step towards said intended destination based upon said profile and said provisional path;
- 25 a processor for determining a personal space around said autonomous entity;
- a processor for determining whether said preferred step is feasible by considering whether obstructions infringe said personal space.